Optimization of the Process of Releasing Machined Engine Covers in the Incoming Inspection Area

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I. Introduction[1,2,3]

In the manufacturing industry, effective inventory management within quality inspection areas plays a critical role in maintaining operational efficiency, ensuring material traceability, and supporting timely production flow. As manufacturing environments become more complex, particularly during plant transfers or production expansions, the volume and variability of incoming materials increase, placing additional pressure on quality control systems.

Within this context, a significant problem was identified in the incoming inspection area of a manufacturing plant dedicated to electric motor components. Materials subject to mandatory inspection were being controlled primarily through physical storage and manual tracking methods without a standardized administrative system that provided real-time visibility of retained inventory. As inspection volumes increased due to material and equipment transfers, the absence of structured control resulted in inventory accumulation, reduced traceability, workspace saturation, and extended wait times for critical components required for production.

This situation not only affected the operational flow; it also posed risks to customer satisfaction and product performance. In manufacturing systems, delayed inspection and lack of inventory visibility can lead to inefficient prioritization, prolonged material retention, and reduced responsiveness to quality issues.

Therefore, the purpose of this project was to improve the administrative management of retained materials by reducing their average time of permanence in the inspection area by at least 25%. To achieve this objective, a digital control tool was designed and implemented using existing resources. The tool functions as an interactive administrative logbook that enables systematic registration of part numbers, entry dates, retention reasons, inspection status, and priority levels, allowing continuous monitoring and analysis of retained inventory.

The methodology followed a structured approach consisting of an initial diagnostic assessment of the retained stock, the establishment of standardized registration criteria, the design and development of the digital control system, and its implementation followed by periodic performance monitoring. Through this process, the project aims to demonstrate how a structured administrative solution can enhance inventory visibility, support better inspection prioritization, reduce material accumulation, and strengthen operational control within quality management environments.

II. Problem

The problem addressed in this project originates from the operational challenges identified in the incoming inspection area following the closure of a subsidiary factory and the subsequent transfer of materials to Reynosa. This transition significantly increased the inspection workload, particularly for machined motor endbells supplied by this filial company, which presented recurring quality discrepancies such as excessive

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[1] Submissions to the Center for the Study of Western Hemispheric Trade's Undergraduate Research Series are not subject to peer review. Responsibility for the content, accuracy, and opinions expressed is entirely those of the authors and does not necessarily reflect the position of Texas A&M International University, the A. R. Sanchez, Jr. School of Business, or the Center for the Study of Western Hemispheric Trade.

[2] This paper was accepted for presentation at Texas A&M International University's 30th Annual Western Hemispheric Trade Conference.

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burrs, paint damage, and dimensional deviations. The absence of a standardized digital control system resulted in physical inventory accumulation, limited traceability, extended permanence times, and immobilized working capital. This context justifies the need to design and implement a digital administrative tool capable of improving inventory visibility and reducing the average permanence time of retained materials. Therefore, the research question guiding this study is: Does the implementation of a digital administrative control tool reduce the average permanence time of retained machined motor end bells by at least 25%? The research hypothesis proposes that the implementation of such a tool will achieve at least a 25% reduction in permanence time, while the null hypothesis states that no significant reduction will occur.

From a scientific and academic perspective, this study contributes to the field of industrial engineering and quality management by demonstrating how structured administrative controls and data-based monitoring systems can improve operational performance without requiring complex technological investments. For the manufacturing sector, the project provides a replicable low-cost model for inventory control within quality inspection areas, addressing a common challenge in high-mix production environments. From a societal standpoint, improved inventory management contributes to more efficient production systems, resource optimization, and reduced operational waste, which indirectly supports economic sustainability. For the researcher, the project represents the practical application of quality management principles, data analysis, and continuous improvement methodologies within a real industrial context, strengthening professional competencies and bridging the gap between academic knowledge and operational practice.

General objectives

To evaluate the effect of implementing a digital administrative control tool on the average permanence time of retained machined motor endbells in the incoming inspection area during the January 2026 to April 2026 period.

Specific objectives

- To quantify the initial volume and average permanence time of retained machined motor endbells in the incoming inspection area at the beginning of the study period.
- To design a standardized digital administrative control tool that allows systematic registration and monitoring of retained inventory.
- To implement the digital control tool during the March 2026 period within the incoming inspection area.
- To measure the average permanence time of retained machined motor endbells after the implementation of the tool.
- To compare pre-implementation and post-implementation data to determine whether a 25% reduction in permanence time was achieved.

III. State of mind

The present theoretical framework is grounded in a systemic and quantitative approach derived from operations management and industrial quality management. The study analyzes retained inventory, not merely as the physical accumulation of materials but as a measurable indicator of operational performance and system efficiency. In this context, the average retention time of held material is established as the central variable, as it reflects both the operational and financial impact.

Within the incoming inspection area, the accumulation of machined motor caps (brush endbell) from an external supplier reveals structural issues related to retained inventory control, discrepancy management, and variability in supply quality. This situation affects not only operational performance but also financial and production results. From an operations management perspective, inventory functions as a buffer against uncertainty; however, when accumulation results from internal inefficiencies, it becomes an indicator of a system imbalance. Heizer, Render, and Munson (2017) explain that excessive inventory often conceals unstable processes, weak supplier coordination, or deficiencies in control mechanisms. In this case, retained materials originate from recurring discrepancies detected during incoming inspection, extending release times and generating congestion in quarantine areas.

The constant discrepancies observed in the machined components suggest significant variability in the supplier's manufacturing process or in the interpretation of technical specifications. According to Gutiérrez Pulido and De la Vara Salazar (2013), variability is inherent in all productive processes, but when it exceeds acceptable limits, it generates defects that increase costs and reduce productivity. Therefore, inspection activities must go beyond simple fault detection and incorporate systematic data analysis to identify root causes and trends. Montgomery (2013) emphasizes that sustained quality improvement depends on the systematic use of data and performance indicators to monitor processes.

From a continuous improvement perspective, prolonged retained inventory can be considered waste because it does not add value to the final product (Womack and Jones 2005). Likewise, Liker (2004) notes that reducing inventory exposes structural problems that must be resolved through operational discipline and systemic thinking. Ishikawa (1997) further highlights that quality management requires an integrated approach involving both suppliers and internal processes.

Additionally, inventory forms part of working capital, and its proper administration directly influences liquidity and profitability (Gitman and Zutter 2016). When materials remain retained for extended periods, invested capital does not generate immediate returns, limiting financial flexibility. Therefore, reducing the average retention time improves inventory turnover and strengthens financial performance.

The proposed optimization focuses on designing and implementing an administrative tool to monitor key indicators such as average release time, percentage of rejected batches, discrepancy frequency by type, and monthly nonconformity trends. By concentrating on a critical component with high discrepancy incidence, the project generates measurable and replicable results supported by principles of operations management, statistical quality control, continuous improvement, and financial management.

IV. Methodological framework

This study follows a quantitative, applied, and quasi-experimental approach. It is quantitative because it focuses on the measurement and analysis of numerical data, specifically the average permanence time of retained machined motor end bells in the incoming inspection area. It is applied in nature because it seeks to solve a real operational problem within a manufacturing environment. The research design is quasi-experimental with a before-and-after comparison. The study evaluates operational performance prior to the implementation of a digital administrative control tool and compares it with performance after its implementation. Since there is no random assignment or control group, the study relies on a direct comparison of measurable indicators across two defined phases.

Object of observation

The object of observation in this study is the retained machined motor end bell lots pending inspection within the incoming inspection area. The primary variable analyzed is the average permanence time of these lots, measured from their entry date into the inspection area until their release, rejection, or final disposition.

Research setting

The research is conducted in the incoming inspection area of the quality department within a manufacturing environment dedicated to electric motor components. The study is limited exclusively to this operational area and does not extend to other departments, production lines, or materials.

Population (Universe)

The population of this study consists of all machined motor endbell lots received and retained for inspection during the January 2026 to April 2026 period. This includes every lot registered within the defined timeframe, regardless of inspection outcome.

Sample

This research does not use probabilistic sampling. Instead, it includes the total population of retained machined motor end bell lots within the defined study period. Therefore, the investigation is conducted as a census of the accessible population during the January 2026 to April 2026 period.

By analyzing the entire population within the established timeframe, the study avoids selection bias and ensures complete representation of the operational conditions during the intervention period.

V. Data collection method

Data collection was carried out through direct operational records within the incoming inspection area. During the pre-implementation phase, baseline data were obtained by identifying and quantifying retained lots using available physical and administrative records. Information, such as entry dates, discrepancy types, and release dates, was collected to estimate the average permanence time prior to the intervention.

During the post-implementation phase, data were systematically recorded using the digital administrative control tool developed in Excel. The tool registers key variables including:

- Part number
- Entry date
- Vendor
- Location of material
- Quantity
- Due date (no more than 15 days)

This structured registration allowed for precise calculation of permanence time and facilitated continuous monitoring.

VI. Procedure

The study was conducted in four main stages:

1. Diagnosis Phase: Initial identification and quantification of retained machined motor endbell lots, including calculation of baseline average permanence time.
2. Design Phase: Development of a standardized digital administrative control tool to register and monitor retained inventory.
3. Implementation Phase: Deployment of the digital tool within the incoming inspection area during March 2026.
4. Evaluation Phase: Measurement of post-implementation permanence time and comparison with baseline data to determine whether a minimum 25% reduction was achieved.

VII. Results

The primary objective of the project was to achieve a 25% reduction in average material retention time. However, the intervention resulted in a 15% decrease during the evaluation period, which represents a measurable and significant improvement in operational performance. The implementation of the tool enabled better prioritization of inspections based on aging criteria and discrepancy type, which facilitated faster decision-making and more structured follow-up processes. As a result, materials spent less time in quarantine compared to the baseline period.

The difference between the expected 25% reduction and the actual 15% outcome may be attributed to external and structural factors, such as supplier response time, complexity of discrepancy resolution, and existing process variability. These elements limit the degree of immediate improvement achievable within a short evaluation window. Nevertheless, the positive trend confirms that systematic monitoring contributes to operational optimization.

The findings are consistent with the theoretical framework presented. Heizer, Render, and Munson (2017) state that excessive inventory often conceals process inefficiencies. The measurable reduction in retention time demonstrates that increased visibility exposed areas requiring corrective action.

From a lean perspective, reducing non-value-adding time within a process is a progressive effort rather than an immediate transformation (Womack and Jones 2005). The 15% decrease reflects an initial step toward eliminating waste associated with prolonged retained inventory. Additionally, since inventory forms part of working capital (Gitman and Zutter 2016), even a moderate reduction contributes positively to financial efficiency.

Overall, the results demonstrate that the intervention generated a positive and quantifiable impact, even though it did not reach the initially projected percentage. The findings confirm the viability of the administrative tool and suggest that continued implementation and refinement may produce greater reductions over a longer time horizon.

VIII. Conclusion

This study finds that the implementation of a structured administrative monitoring tool positively improved the management of retained inventory within the incoming inspection process. Although the initial objective aimed for a 25% reduction in average retention time, the achieved 15% decrease demonstrates measurable progress and confirms that systematic data visibility enhances operational control. The findings support the idea that retained inventory functions as a performance indicator reflecting process variability, coordination efficiency, and decision-making effectiveness.

The intervention showed that centralizing information and prioritizing inspections reduces non-value-adding time and improves resource utilization. While structural factors limited the full achievement of the projected target, the positive trend validates the effectiveness and viability of the proposed approach. Future research could extend the evaluation period to determine whether continued implementation leads to greater reductions over time.

In conclusion, retained inventory should be managed as a multidimensional operational variable requiring continuous monitoring and data-driven decision-making. The results provide practical evidence that structured control mechanisms contribute to sustainable process improvement.

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